

# Unraveling the biometric complexity of Beringian Dunlin

*Calidris alpina*

*arctica, pacifica, sakhalina, kistchinski, actites*

***Sex and subspecies determination at various geographic  
scales***



***Alaska Shorebird Group 8 Dec 2011***

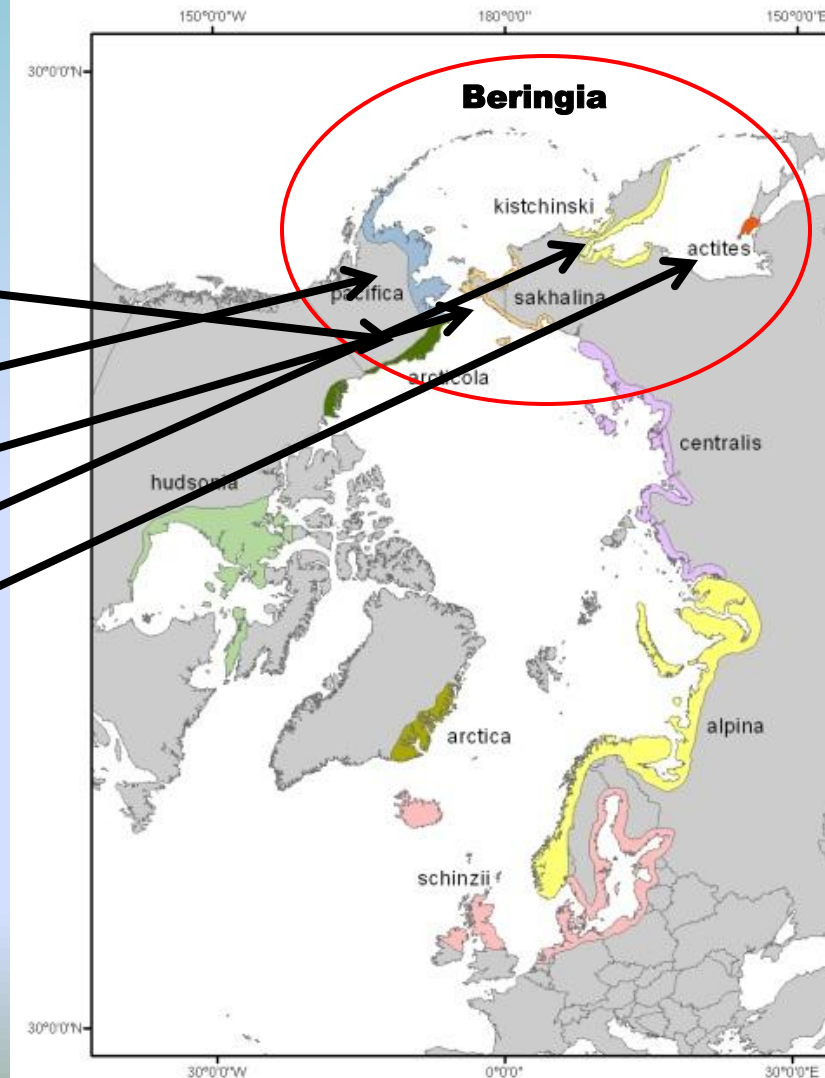
***River Gates, Rick Lanctot, Abby Powell, Stephen  
Yezerinac, Pavel Tomkovich and Olga Valchuk***

# *Circumpolar distribution of Dunlin*



5 Dunlin subspecies  
breeding in  
Beringia:

*arcticola*  
*pacifica*  
*sakhalina*  
*kistchinski*  
*actites*





# *Dunlin subspecies*



*arctica*

*sakhalina*

*schinzii*

*alpina*

Dunlin have 8 - 10 subspecies (Browning 1991, Engelmoor and Roselaar 1998)

Based on different

- breeding locations
- biometrics
- alternate plumage variation

Varies by:

- Extent of red on crown
- Back color
- Belly color
- Streaking on breast

# *Differences between sexes*



**Male**



**Female**



**Indistinct dichromatism      male > female**

**Sexual dimorphism      female > male**

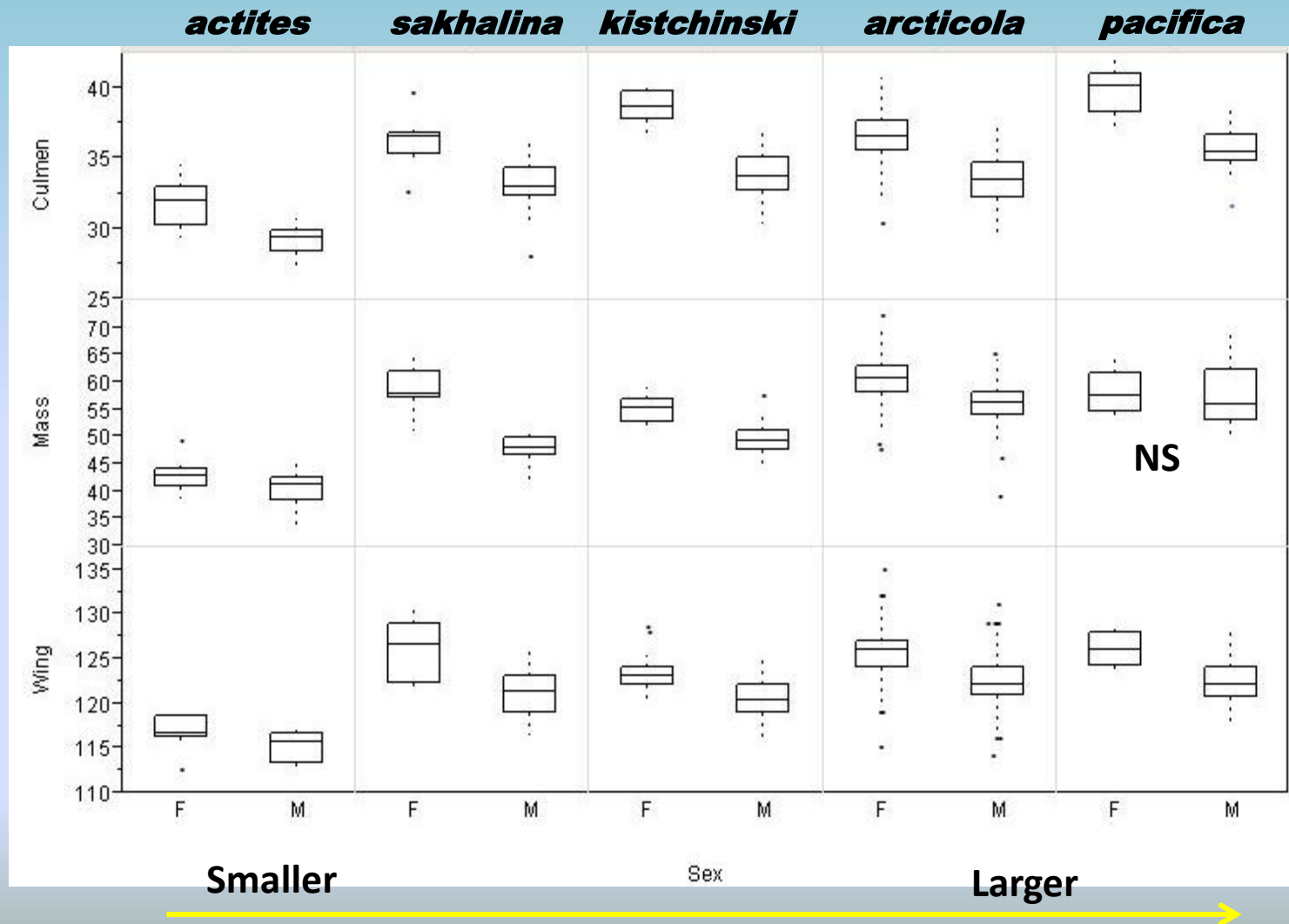
**Varies by:**

**sex**

**age**

**individual plumage variation**

# Dunlin sexual dimorphism

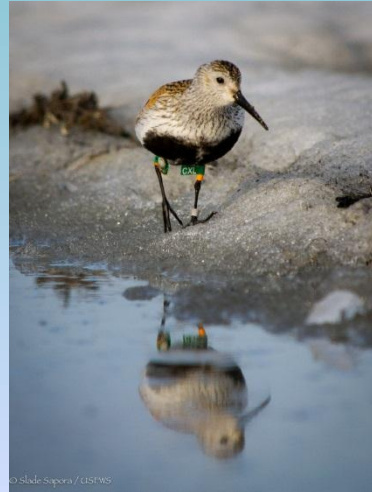


# Why is this important?



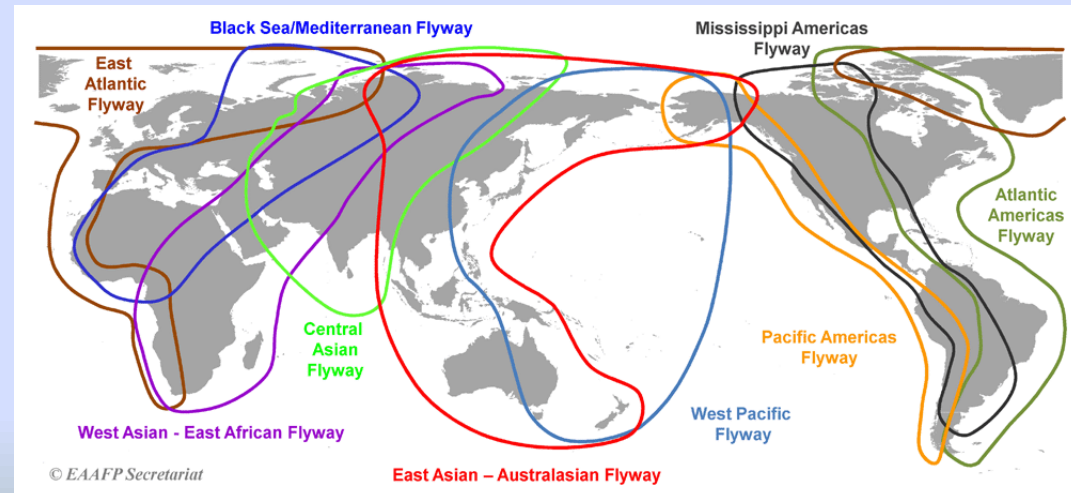
## *Breeding*

sex & subspecies - specific  
demographic rates



## *Non-breeding*

composition of mixed sex  
and subspecies assemblages  
at wintering/migration sites







# ***Current methods and limitations***

**Biometric techniques and alternate plumage variation used to delineate groups**

- ***limit*** - - alternate plumage not useful during non-breeding season
- ***limit*** - - 15 - 25% overlap in dimorphism

**Molecular techniques (e.g. stable isotopes, genetics) work well for populations with high variation**

- ***limit*** - - lack of variation in physical biogeochemistry in breeding range (Wunder et al.)
- ***limit*** - - genetic lineage not distinct for phenotypic flyway separation of *arctica* and *pacifica* (Haig et al. )

# Objectives



**Standard morphometric measures (e.g. culmen, total head, tarsus, wing and mass) to differentiate between five subspecies of Beringia Dunlin**

- 1) describe the degree of sexual dimorphism in each subspecies**
- 2) assess the utility of using discriminant function models to classifying individuals to either sex or subspecies at migration and wintering sites where groups overlap**



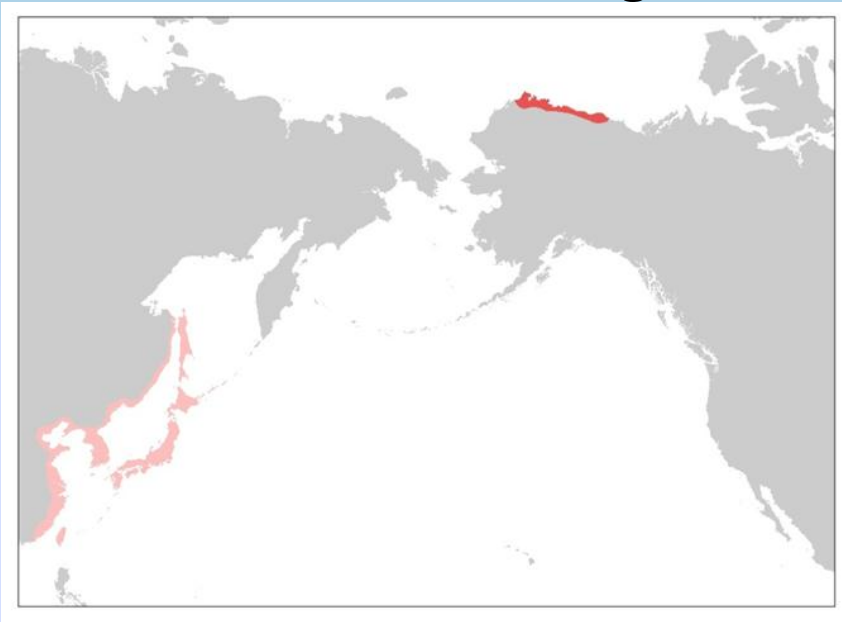


# East Asia Australasian Flyway



*actites, arctica, kistchinski, sakhalina*

**Non-breeding**



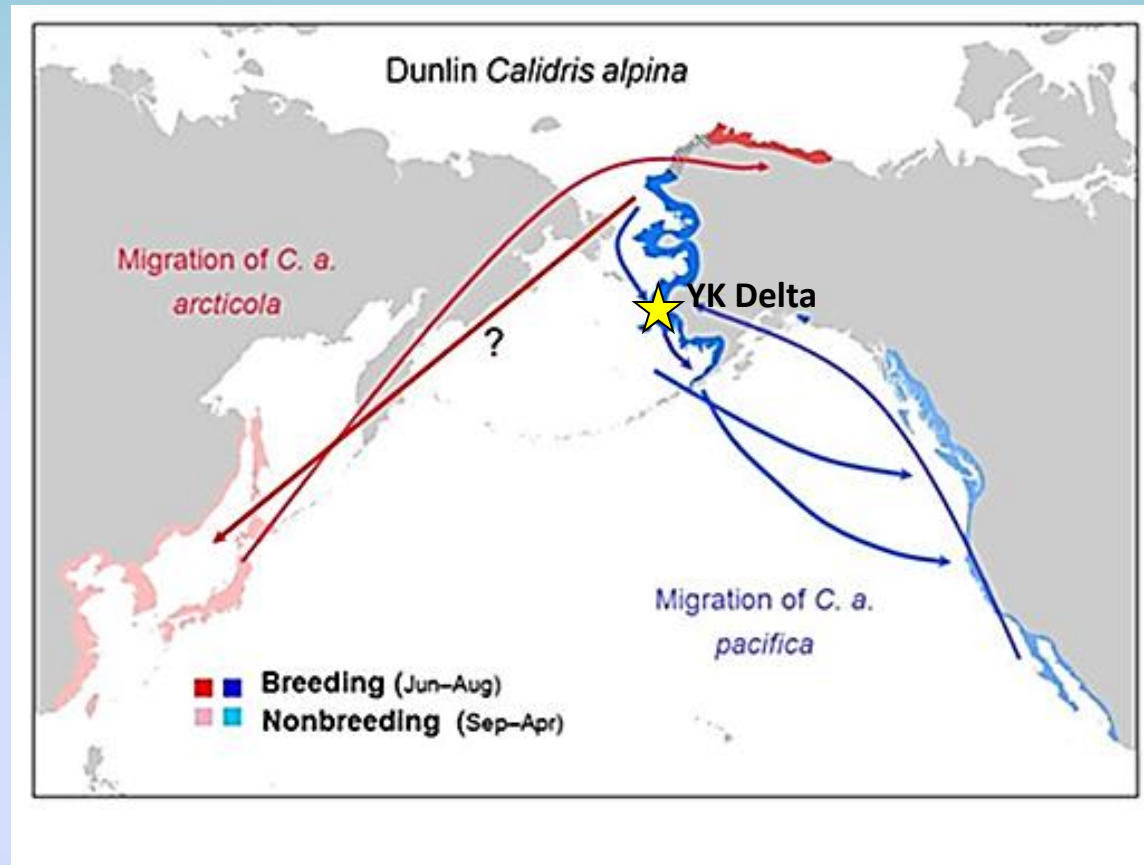
**Breeding**



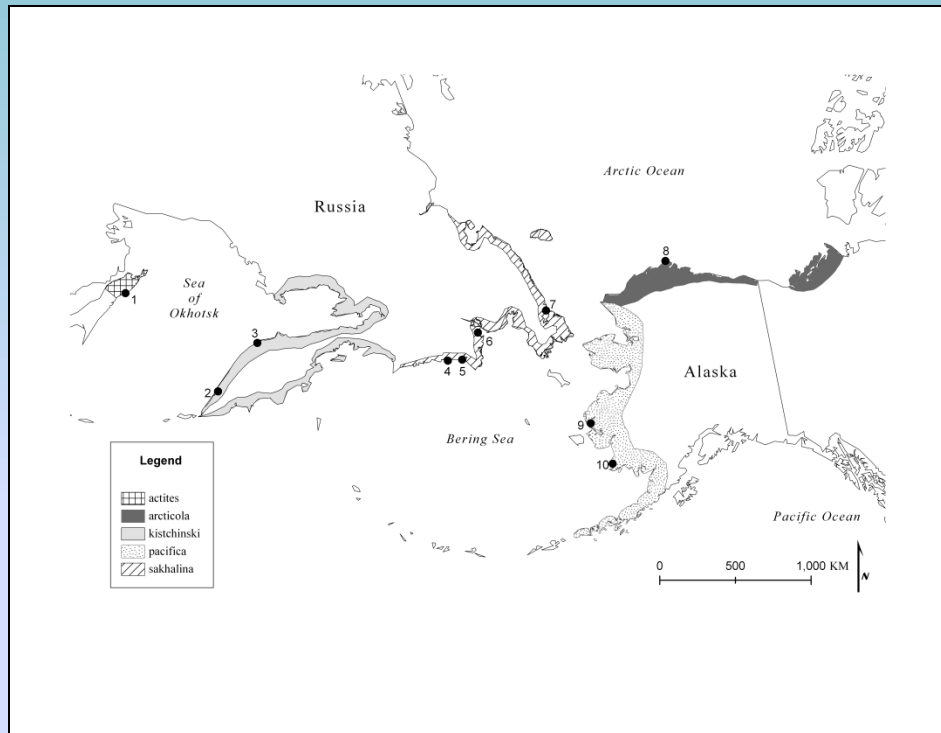
# Western Alaska Fall Stopover



***pacifica* and *arctica***



# Sampling locations



## Obtained Russian subspecies data from collaborators

<i>actites</i>	1 location	$n = 25$
<i>kistchinski</i>	2 locations	$n = 43$
<i>sakhalina</i>	4 locations	$n = 36$
<i>arcticola</i>	1 location	$n = 341$
<i>pacifica</i>	2 locations	$n = 46$



# ***Morphometric techniques***



**All observers trained in measurement methods**

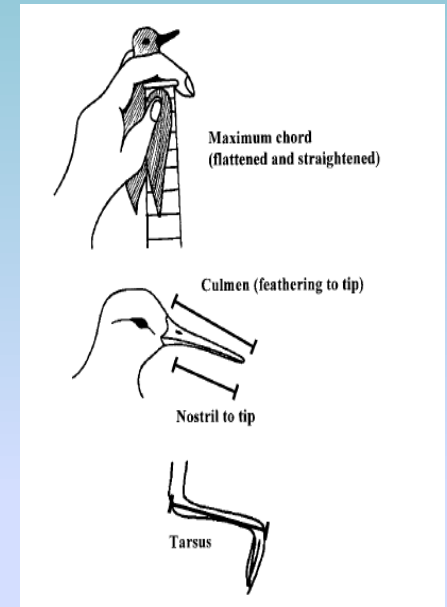
**Exposed culmen**

**Total head**

**Tarsus**

**Flattened wing chord**

**Mass**



# *Molecular sex determination*



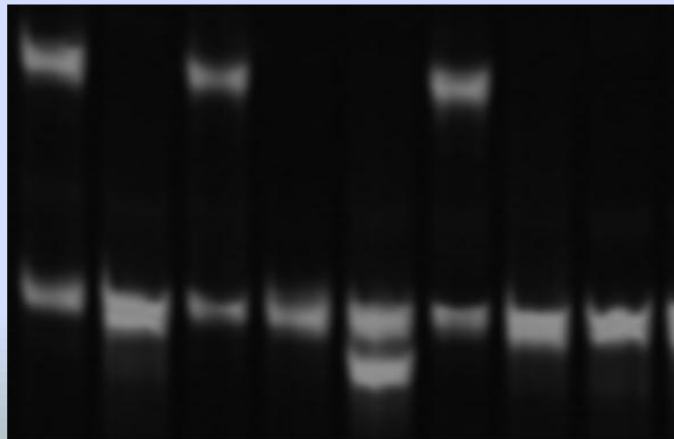
To reduce variation within a subspecies we 1<sup>st</sup> determined sex  
Molecular samples

Blood and feather

PCR amplification of the CHD-W/CHD-Z genes  
(Griffiths et. al 1998)

Collections

WZ ZZ WZ ZZ ZZ' Chromosomes



F M F M M Sex





# ***Analyses***

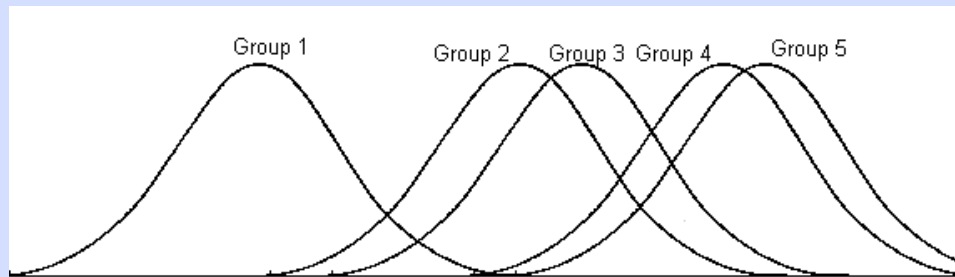
**Known sex and recognized subspecies breeding popn.**

**Tested for differences between sexes for each character**

**One-way ANOVA with Tukey-Kramer (HSD)**

**Unique discriminant function models (DFA) for each subspecies to determine sex**

**Differences in subspecies discriminant function model to classify individuals**



**Used highest square canonical correlation (SCC) value to determine best model**



# Sex DFAs



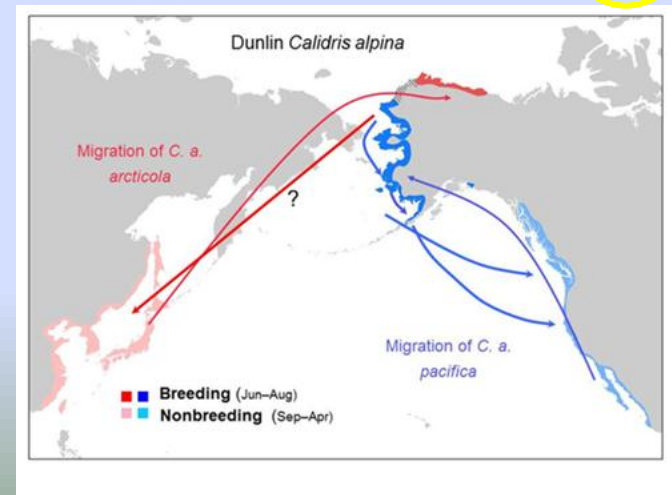
Discriminant function models	Correct classification		
	♀	♂	Total
<i>actites</i> n = 25			
Culmen, total head, tarsus, wing, body mass	92 %	100 %	96 %
<i>kistchinski</i> n = 43			
Culmen, body mass	100 %	96 %	98 %
<i>sakhalina</i> n = 36			
Culmen, total head, tarsus, wing, body mass	90 %	100 %	97 %
<i>arctica</i> n = 341			
Culmen, tarsus, wing, body mass	88 %	86 %	87 %
<i>pacifica</i> n = 46			
Culmen, total head, tarsus, wing, body mass	95 %	96 %	96 %



# Sex DFA : *arctica* and *pacifica*



culmen, total head, tarsus, wing	<i>n</i>	Correct classification		
		<i>arc</i>	<i>pac</i>	Total
sex is unknown	100	69 %	78 %	73 %
sex is male	54	82 %	89 %	85 %
sex is female	46	81 %	75%	78%



# Subspecies DFA East Asian Australasian



*actites, arctica, kistchinski, sakhalina*

Discriminant function models

Correct classification percent

		<i>act</i>	<i>arc</i>	<i>kis</i>	<i>sak</i>	Total
	<i>n</i>	13	19	26	26	84
Sex is male		100 %	58 %	39 %	53 %	57 %
	<i>n</i>	12	21	17	10	60
Sex is female		100 %	57 %	94 %	60 %	77 %







# ***Conclusions***

**Beringian Dunlin can be sexed reliably with DF models and morphometric measures (86 - 100 % correct classification)**

**Subspecies are harder to differentiate**

**Western AK: 69 - 89 %**

**EAA Flyway: 39 - 100 %**

**Knowing sex helps to improve the classification of the subspecies**

**Only *actites* subspecies within the EAA Flyway can be differentiated**  
***actites* population is ~400 individuals**



# ***What can we do with these DFA***

**Determine sex of Dunlin during different periods of the life cycle**

- **breeding**
- **EAAF migration and wintering**
- **Western Alaska staging**

**Determine the subspecies at different geographic locations**

- **EAAF migration and wintering**
- **Western Alaska staging**

**Assists managers in understanding the relative importance of wintering and staging locations**

**Subspecies with small or declining populations may be sensitive to habitat loss and alteration**

# Acknowledgements

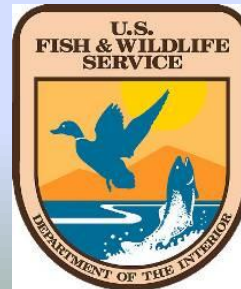


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***Questions?***